REMARKS

Reconsideration and allowance of the subject application in view of the foregoing amendments and the following remarks is respectfully requested. . This Amendment should be entered under Rule 116 because it places this application in condition for allowance.

Claims 12 and 17-22 remain pending in the application. By this amendment claim 12 is amended

In the invention, two types of microstructure, holes and pillars, are etched on a surface, in a particular arrangement. The invention make use of a specificity of the holes and the pillars, wherein their profiles of variation of the effective index with the fill factor <u>are the inverse of each other</u>: the effective index of the holes decreases when the fill factor increases, while the effective index of the pillars decreases when the fill factor increases.

According one aspect of the invention, a combined arrangement of holes and pillars, exploits their inverse profiles of variation of the effective index with the fill factor, in order to compensate for the dispersion with the wavelength. See paragraphs [0074], [0076], [0081], and Figs.9a and 10b.

The structure of the invention uses holes to code the lower values of f and pillars to code the high values of f, where the effective index along the direction of the f increasing, decreases for the holes, i.e. the holes are bigger and bigger, and increases for the pillars, i.e. the pillars are smaller and smaller.

The lower value of f, which is 0 in the example of FIG.9a, is coded by the hole corresponding to the maximum effective index, i.e., the smallest hole, obtained by removing the smallest quantity of material.

The highest value of f, which is 0.68 in the example of FIG.9a, is coded by the pillar corresponding to the minimum effective index, i.e., the smallest pillar obtained by removing (all around) the largest quantity of material.

In addition, "[t]he first point is encoded by f=0 with a hole type microstructure. The last point is encoded by a pillar type microstructure encoded with f=0.68" (*see* paragraph [0127] and the annexed fig.9a).

According to another aspect of the invention, a characterization parameter α has been defined, which, combined with the arrangement of holes and pillars as disclosed above, enables an optimal, concrete, design of an optical element, taking account of all the technical limitations, so to create an artificial composite material having a blazing effect over a wide spectral band (see paragraphs [0084-0085]).

Objections to the Amendment filed January 6, 2009

The amendment filed on January 6, 2009 stands objected to under 35 USC 132(a) because it added material which was not supported by the original specification. Specifically, the asserted unsupported added material is recited in claim 12 and includes the phrase "first portion ... first pillar type geometry ... the effective index decreases with an increasing fill factor ... a second portion ... a second hole type geometry ... the effective refractive increases in the same direction of increasing fill factor." Applicants agree with the Examiner and amend claim 12 to correct the typographical error.

As pointed out by the Examiner, and as clear from the disclosure of the invention, as presented above, the effective index of the holes decreases when the fill factor increases, while the effective index of the pillars decreases when the fill factor increases. Applicants amend claim 12 to restore the objected to portion of claim 12 back to the previously presented claim language. Accordingly, withdrawal of the objection to the drawings is respectfully requested.

Rejections under 35 USC 112

The January 6th amendment to claim 12 further resulted in a rejection of claims 12 and 17-22 under 35 U.S.C. 112, first paragraph, as failing to comply with the written

description requirement. As presented above, claim 12 is amended to obviate the rejection thereof. Accordingly, withdrawal of this rejection is respectfully requested.

Objections to the Disclosure

The Office Action indicates that the disclosure is objected to because the equation for the parameter α contains a typographical error. Applicants respectfully disagree. Although Applicants' specification, submitted with the preliminary amendment filed April 14, 2006, correctly contains the following formula at page 8, lines 12-13,

$\Delta n(\lambda_0) = n_{max}(\lambda_0) - n_{min}(\lambda_0)$, $\delta n_{min} = n_{min}(\lambda_0) - n_{min}(\lambda_\infty)$ and $\delta n_{max} = n_{max}(\lambda_0) - n_{max}(\lambda_\infty)$.

The published application, at paragraph [0041] incorrectly indicates the last --λ_∞-- as --λ_{28}--. Because this error was introduced into the published application by the Patent and Trademark Office (PTO), withdrawal of this rejection is respectfully requested.

Claim Rejections Under 35 USC §103(a)

Claims 12 and 17-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over the article "Diffractive Phase Elements Based on Two-Dimensional Artificial Dielectric" by Chen et al. (Optics Letters, Vol. 20, No. 2, pages 121-123). This rejection is respectfully traversed for the reasons discussed below.

Chen relates to a diffractive element <u>for a use under a single, design, wavelength, of 633 nanometers</u>. The structure of Chen is efficient at the design wavelength. Chen, however, <u>does not concern or suggest at all a possible or intentional use over a wide spectral band</u>. No indication can be found nor any suggestion that a possible broadband element can be obtain through the design of Chen.

Furthermore, although Chen appears to disclose the use of two types of binary microstructures, holes and pillars, with a variation of the filling factor, in quartz, having a

refractive index n of 1.46, nowhere does Chen disclose nor suggest a particular arrangement of these holes and pillars so to exploit the inverse dispersion of the effective index with the wavelength. Indeed, Chen cannot suggest the features of the Applicants' device at least because Chen appears to only concern itself with an optical element for a 633 nanometers wavelength. Therefore, at least for this reason, there is no motive, no incitation in Chen to define holes and pillars as claimed in the invention for dispersion compensation over a wide spectral range.

On page 5 of the OA, the Examiner indicates that "*its is implicitly true that the optical material such as quartz of fused silica has implicit dispersion property of the artificial material based on quartz, namely the refractive index is a non-constant function of the wavelength. The α parameter is nothing but the dispersion property of the artificial material based on quartz. From Figures 1 and 2 , one can, easily obtain the maximum and minimum effective indices with respect to the fill factors. And with inherent dispersion property for the composite material one can deduce the parameter as claimed.* " Applicants respectfully disagree for the following reasons:

I. Figures 1 and 2 in Chen are derived from Eq(1) and (2) of page 121 and show upper and lower bounds of the effective indices as a function of the fill factor. First, on page 121, right column, Chen states that "*the bounds are very narrow", e.g., <2% for fused quartz and air,"* suggesting that at a given fill factor, there is not much variation.

Second, Figures 1 and 2 do not show variations with the wavelength. Thus, nowhere does Chen suggest any high dispersion of the effective indices with the wavelength.

II. The Examiner alleges that "quartz has implicit dispersion property, namely that the refractive index is a non-constant function of the wavelength, and then asserts that the α parameter is nothing but the dispersion property of the artificial material based on quartz."

Applicants respectfully submit that the Examiner's linking, in the same sentence, the refractive index of the quartz and the dispersion property of the artificial material based on quartz, is improper and mischaracterizes Chen. Indeed, the idea behind Chen is the high dispersion (wavelength variation) of the effective index of the artificial material (which is structured at a sub-wavelength scale), and not the dispersion of the refractive index of the structured material, assuming that the dispersion of the refractive index of the material in which are etched the sub-wavelength structure is small (see [0015] that states: "For these diffractive optical elements, it can be assumed that $\Delta n(\lambda) = \Delta n(\lambda_0)$ because the dispersion of the material is negligible: the refractive index varies little around λ_0." We speak therefore regarding the dispersion of the non-etched, bulked material. For instance, regarding quartz: at 633nm, n=1,46 at the design wavelength, at 583nm n is equal to 1.45869 and at 683nm n is equal to 1.45575 showing a refractive index variation of 0.0029 for a 100nm wavelength variation.

Applicants respectfully submit that the instant invention does not relate to the subject matter of Chen. In the claimed device, Applicants assume that the dispersion of the refractive index of the material in which are etched the sub-wavelength structure is small, and the higher the refraction index of the bulk, non etched material, the higher the dispersion of the effective index of the artificial material will be.

Quartz is not a material with a high refractive index, thus it cannot enable a high dispersion of the effective indices of the artificial material. Those of ordinary skill in the art can expect poor performance for broadband structures (see III below). Accordingly, Applicants respectfully submit that Chen is based on a quartz structure and teaches away from the claimed invention.

III. Chen does not suggest, or describes the definition and/or the use of the parameter α for the definition of the holes and pillars of the structure, exploiting the variation of the effective indices as a function of both the fill factor and the wavelength. In fact the parameter α is a representation of the variation of the effective indices as a function of both the fill factor and the wavelength.

In addition, coefficient α cannot be calculated only with Figures 1 and 2 of Chen I, because these figures do not give the effective index variation with the wavelength, as a function of the fill factor. However coefficient α can be calculated through other data found in Chen.

According to the claimed invention:

$$\alpha=\frac{(\delta n_{\min}-\delta n_{\max})}{\Delta n(\lambda_0)}.$$

When calculating the effective index for square pillars (negative slope curves) and square holes (positive sloped curves) etched into quartz (refractive index n=1.46 at 633nm), at λ_0=633nm (continuous lines) and λ_∞ (dash-dotted lines), see Figure A below that illustrates the dispersion with the wavelength of the effective index for a given fill factor. Using Figure A, we can find the effective index variation as a function of the fill factor.

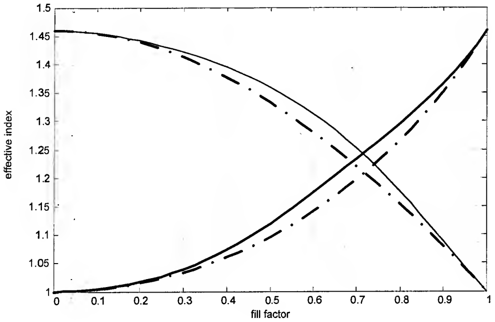

Figure A: effective index as a function of the fill factor at λ_0=633nm (continuous curves) and at λ_∞ (dash-dotted curves) of a periodic structure composed of square pillars (positive slope curves) and square holes (negative slope curves). The period of the structure is 400 nm, the material (quartz) refractive index is 1.46.

Now, according to Chen (page 122, "*six roughly equally spaced effective indices, ranging from 1.07 to 1.46, were used to obtain the desired blazing effect"),* the effective index varies between 1.07 and 1.46. Then:

$\delta n_{min} = n_{min}(\lambda_0) - n_{min}(\lambda_\infty) = 0.013$

$\delta n_{max} = n_{max}(\lambda_0) - n_{max}(\lambda_\infty) = 0$

so $\Delta n(\lambda_0) = n_{max}(\lambda_0) - n_{min}(\lambda_0) = 1.46 - 1.07 = 0.39$

So $\alpha = \frac{(\delta n_{min} - \delta n_{max})}{\Delta n(\lambda_0)}$ **= 0.013/ 0.39=0.0339.**

This value is very close to 0. As a result, the efficiency with the spectral wavelength behavior will not be good.

In fact, if we take the equation (6) in paragraph [0098] and equation (3) in

paragraph [0101] page 6 of the publication of the present application, with coefficient α=0.0339, we can compute the efficiency as a function of the wavelength, (*see* Figure B below).

As compared to the example given in the invention in Figure 5 and described in paragraph [0104], with a structure characterized by an λ value of 0.39, it becomes clear that the structure proposed by Chen does not offer efficient broadband behavior.

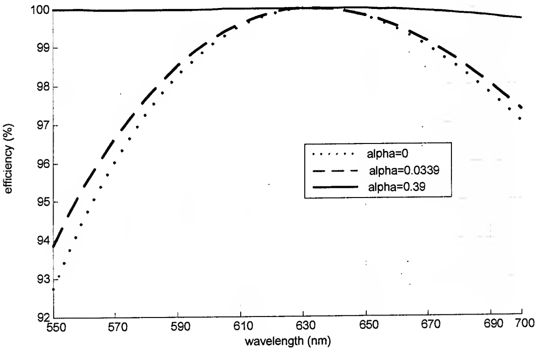

Figure B: Efficiency behavior as a function of the wavelength for three different structures, characterized by three values of α : 0, 0.0339 and 0.39.

Fig. B illustrates that although Chen may prove efficient at the design wavelength, Chen fails to disclose a structure exhibiting broadband behavior as efficiently as that disclosed by Applicants.

Thus, at least for the reasons detailed above, there is no element or suggestion in Chen to define such an optimization parameter α, with a condition α>0 which, when

combined with the claimed arrangement of holes and pillars, enables an optimal, concrete, design of an optical element, taking account of all the technical limitations, so to create an artificial composite material having a blazing effect over a wide spectral band.

In addition, specifically regarding claim dependent claim 19, there is no element or suggestion in Chen to define such an optimization parameter α, with a condition $0.3 \leq \alpha \leq 0.5$ which, combined with the arrangement of holes and pillars as claimed, enables an optimal, concrete, design of an optical element, taking account of all the technical limitations, so to create an artificial composite material having a blazing effect over a wide spectral band.

Thus Chen cannot suggest nor make evident a characterization parameter enabling the design of an optical element as claimed in the invention, with a definition of the fill factors of the holes and pillars as claimed, to obtain compensation of the dispersion with the wavelengths, so to have a blaze effect over a wide spectral range.

Applicants respectfully submit that claim 12 is patentable at least due to the failure of Chen to disclose, teach or motivate all recited features of claim 12. Claims 17-22 depend from this independent claim and are likewise patentable over Chen for at least their dependence on an allowable base claim, as well as for the additional features they recite. Accordingly, withdrawal of this rejection is respectfully requested.

Conclusion

All objections and rejections having been addressed, it is respectfully submitted that the application is in condition for allowance and a Notice to that effect is earnestly solicited.

The Examiner is invited to telephone the undersigned, Applicants' attorney of record, to facilitate advancement of the present application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,

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